

What Is Claimed Is:

1. A method for predicting a plurality of surface multiples for a plurality of traces in a record of seismic data, comprising:

- (a) selecting a target subsurface line;
- (b) selecting an input subsurface line within an aperture of the target subsurface line;
- (c) selecting a point on a line twice the distance between the input subsurface line and the target subsurface line, wherein the point corresponds to a potential downward reflection point of the surface multiples for a trace in the record;
- (d) generating a potential surface multiple for the trace corresponding to the point;
- (e) repeating steps (c) through (d) for each point on the line to generate an inline of potential surface multiples for the trace corresponding to each point on the line;
- (f) repeating steps (b) through (e) for each input subsurface line within the aperture of the target subsurface line to generate a plurality of potential surface multiples for the trace corresponding to each input subsurface line within the aperture; and
- (g) adding the plurality of potential surface multiples corresponding to each input subsurface line within the aperture to generate a surface multiple for the trace.

2. The method of claim 1, further comprising:

- preconditioning the record into a plurality of subsurface lines; and
- repeating steps (a) through (g) for each preconditioned subsurface line to generate the surface multiples for the traces in the record, wherein each preconditioned subsurface line is the target subsurface line.

3. The method of claim 1, wherein generating the potential surface multiple for the trace corresponding to the point comprises:

simulating a first potential trace having a source located at the same location as a source for the trace and a receiver located at the point; and

simulating a second potential trace having a source located at the point and a receiver located at the same location as a receiver for the trace.

4. The method of claim 3, further comprising convolving the first potential trace and the second potential trace to generate a potential surface multiple for the trace corresponding to the point.

5. The method of claim 3, wherein simulating the first potential trace comprises:
extracting a first simulating trace from the input subsurface line, wherein the first simulating trace corresponds to the first potential trace; and
applying a differential moveout correction to the first simulating trace.

6. The method of claim 5, wherein the differential moveout correction is a differential normal moveout correction.

7. The method of claim 3, wherein simulating the second potential trace comprises:

extracting a second simulating trace from the input subsurface line, wherein the second simulating trace corresponds to the second potential trace; and
applying a differential moveout correction to the second simulating trace.

8. The method of claim 7, wherein the differential moveout correction is a differential normal moveout correction.

9. The method of claim 1, further comprising, prior to selecting the target subsurface line:

separating the record of seismic data into a plurality of subsurface lines;
regularizing the subsurface lines; and
extrapolating the subsurface lines.

10. The method of claim 9, wherein selecting the target subsurface line comprises selecting the target subsurface line from the regularized and extrapolated subsurface lines.

11. The method of claim 1, wherein the potential surface multiple constitutes a trace from a multiple contribution gather for the trace.

12. A method for predicting a plurality of surface multiples for a plurality of traces in a record of seismic data, comprising:

- (a) selecting a target subsurface line;
- (b) selecting an input subsurface line within an aperture of the target subsurface line;
- (c) applying a differential moveout correction to the input subsurface line;
- (d) performing a two dimensional surface multiple prediction on the input subsurface line to generate a sum of a plurality of potential surface multiples on an inline in each multiple contribution gather that corresponds to the target subsurface line, wherein the inline corresponds to the input subsurface line;
- (e) repeating steps (c) through (d) for every input subsurface line within the aperture to generate a plurality of sums of potential surface multiples on every inline in every multiple contribution gather that corresponds to the target subsurface line;
- (f) sorting the plurality of sums of potential surface multiples such that each sum of potential surface multiples corresponding to a trace in the record is adjacent to each other; and
- (g) adding the adjacent potential surface multiples corresponding to the trace to generate a surface multiple for the trace.

13. The method of claim 12, further comprising:
preconditioning the record into a plurality of subsurface lines; and
repeating steps (a) through (g) for each preconditioned subsurface line to generate the surface multiples for the traces in the record.

14. The method of claim 12, wherein the differential moveout correction is a differential normal moveout correction.
15. The method of claim 12, further comprising, prior to selecting the target subsurface line:
- separating the record of seismic data into a plurality of subsurface lines;
 - regularizing the subsurface lines; and
 - extrapolating the subsurface lines.
16. The method of claim 15, wherein selecting the target subsurface line comprises selecting the target subsurface line from the regularized and extrapolated subsurface lines.
17. A computer readable medium containing a program which, when executed, performs an operation comprising:
- (a) selecting a target subsurface line;
 - (b) selecting an input subsurface line within an aperture of the target subsurface line;
 - (c) selecting a point on a line twice the distance between the input subsurface line and the target subsurface line, wherein the point corresponds to a potential downward reflection point of the surface multiples for a trace in the record;
 - (d) generating a potential surface multiple for the trace corresponding to the point;
 - (e) repeating steps (c) through (d) for each point on the line to generate an inline of potential surface multiples for the trace corresponding to each point on the line;
 - (f) repeating steps (b) through (e) for each input subsurface line within the aperture of the target subsurface line to generate a plurality of potential surface multiples for the trace corresponding to each input subsurface line within the aperture; and

(g) adding the plurality of potential surface multiples corresponding to each input subsurface line within the aperture to generate a surface multiple for the trace.

18. The computer readable medium of claim 17, wherein the program further contains operation comprising:

preconditioning the record into a plurality of subsurface lines; and

repeating steps (a) through (g) for each preconditioned subsurface line to generate the surface multiples for the traces in the record.

19. The computer readable medium of claim 17, wherein generating the potential surface multiple for the trace corresponding to the point comprises:

simulating a first potential trace having a source located at the same location as a source for the trace and a receiver located at the point; and

simulating a second potential trace having a source located at the point and a receiver located at the same location as a receiver for the trace.

20. The computer readable medium of claim 19, wherein the program further contains operation comprising convolving the first potential trace and the second potential trace to generate a potential surface multiple for the trace corresponding to the point.

21. The computer readable medium of claim 19, wherein simulating the first potential trace comprises:

extracting a first simulating trace from the input subsurface line, wherein the first simulating trace corresponds to the first potential trace; and

applying a differential moveout correction to the first simulating trace.

22. The method of claim 21, wherein the differential moveout correction is a differential normal moveout correction.

23. A computer readable medium containing a program which, when executed, performs an operation comprising:

(a) selecting a target subsurface line;

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(b) selecting an input subsurface line within an aperture of the target subsurface line;

(c) applying a differential moveout correction to the input subsurface line;

(d) performing a two dimensional surface multiple prediction on the input subsurface line to generate a sum of a plurality of potential surface multiples on an inline in each multiple contribution gather that corresponds to the target subsurface line, wherein the inline corresponds to the input subsurface line;

(e) repeating steps (c) through (d) for every input subsurface line within the aperture to generate a plurality of sums of potential surface multiples on every inline in every multiple contribution gather that corresponds to the target subsurface line;

(f) sorting the plurality of sums of potential surface multiples such that each sum of potential surface multiples corresponding to a trace in the record is adjacent to each other; and

(g) adding the adjacent potential surface multiples corresponding to the trace to generate a surface multiple for the trace.